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method of correlation is given in detail with the necessary mathematical formulae and the protogamic surface.

The chapter on mortality is especially attractive. It is perhaps here more than anywhere else in the book that the author shows how advanced he really is in modern statistical matters. While other authors are content to harp on the old methods of constructing mortality tables along the well-known orthodox lines, Mr. Knibbs investigates the secular changes in mortality by a mathematical process and shows the necessity of constructing what he terms "fluent life tables." In the same connection he discusses also what he calls the "plasticity curve" as well as the composite character of aggregate mortality according to age and according to causes of death. Mr. Knibbs is here touching upon the same ideas which of late years have been taken up by the Scandinavian school of mathematical statistics, although by a different mode of treatment. He divides causes of death as regards *relative* frequency according to age in four typical groups.

In a brief space like this it is of course impossible to do full justice to a work planned on so large and broad a scale. A few selections from the foreword might, however, not be out of place. Mr. Knibbs says here that

"In the realm of official statistics there is an enormous amount of accumulated material, which decade after decade, remains unanalyzed and uninterpreted. This is due to several things, *viz.*, to the fact that routine tabulations largely occupy the energies of the staffs of statistical bureaux, to the fact that much of the mass of material is defective and its correction involves more time than is available, and perhaps still more to the fact that appropriate schemes of mathematical analysis have as yet either not been developed, or are regarded as inapplicable."

In the present monograph Mr. Knibbs has materially advanced our knowledge of such mathematical methods and all earnest students will be thankful to him for it. The Australian Government also deserves high praise for having made possible the publication of this volume. We doubt whether public money has ever been expended in a better undertaking of statistical publications than the present work by the eminent scholar of the young and vigorous nation under the Southern Cross.

ARNE FISHER.

Harald Westergaard: "Statistikens Teori i Grundrids" (Outline of the Theory of Statistics). Second edition, completely rewritten, pp. 430, large octavo. Published through a grant of the University of Copenhagen by the C. E. Gad Publishing Company, Copenhagen, 1916.

This is one of the most important text-books on the theory of statistics that has appeared in recent years, and even a belated review of it may be welcomed by American readers for several reasons. Professor Westergaard is one of the leading statisticians of the world and has produced one of the finest treatises ever written on the theory of statistics. But the prime motive in penning this review is to correct certain erroneous opinions which we believe many English-speaking students are likely to form

in regard to the contents of this work. Curiously enough, such opinions about the exact character of Westergaard's book seem to have been caused chiefly by two recent articles from the pen of the same author: "Scope and Methods of Statistics" which appeared in the September number of this QUARTERLY, 1916, and a later one, "On the Future of Statistics," published in the May number, 1918, of the *Journal of the Royal Statistical Society*. These two very able articles leave one perhaps with the feeling that the distinguished Danish scholar is opposed to mathematical methods in statistical analysis, and for this reason they might be used (and in fact they have been used) as a very effective weapon against the small group of students who valiantly struggle—often against great odds—for the treatment of statistical mass data by mathematical formulae. Nothing, however, can be farther from the truth than the assumption that Professor Westergaard views mathematical statistics askance.

Westergaard is unquestionably one of the foremost leaders and advocates of the application of mathematical methods to the field of statistics; and his present work teems with mathematical formulae that require not only a knowledge of elementary algebra but also an extensive study of the differential and integral calculus. Readers who turn to "Statistikens Teori" in the belief that it is an exposition along the well-known lines of the German school of von Mayr and his American followers, like Mayo-Smith and H. Sechrist, will therefore be disappointed.

Westergaard calls the theory of mathematical statistics an absolutely necessary "Tjener" (servant) in a number of investigations relating to so widely different subjects as social science, economics, medicine, heredity, biology, psychology, psychophysics, astronomy, physics and chemistry. The enormous development of statistics and statistical methods arises from the fact that the practical application of such methods lay hidden in the mathematical reasoning of a Bernoulli and a Laplace. It thus appears that mathematical statistics instead of being a mere foundling must be regarded as a science of old and renowned ancestry, dating back to a period when statistical data were very scant if at all available.

In a brief and lucid introduction the author characterizes the different statistical problems and then in the next three chapters deals with the history of statistics under these headings: "Statskundskab" (Science of Government), "The Political Arithmetic and Mathematical Theory of Probability," and "Modern Statistics." These three chapters contain a compact and at the same time complete description of the essential development of statistical methods down to the present time. In the fifth chapter the treatment of the collected data and their preliminary classification and analysis are described. This chapter deals with non-mathematical methods along the lines followed in the elementary works of Bowley and the newly issued text-book by Sechrist. In the sixth chapter, which is entitled "The Regularity in Games of Chance and Similar Observations," Westergaard leaves the elementary and arithmetical methods behind and plunges into the application of the theory of probabilities.

Chapter VII continues with the development of the exponential curve

of the Laplacean-Gaussian Normal Curve of Errors derived from the point binomial by the methods of Laplace and Poisson. Here it becomes absolutely clear that Westergaard by no means ignores the mathematical formulae. Pages 130-162 teem with signs of integration and symbols from higher mathematics. The same exclusive mathematical treatment is continued in the eighth and ninth chapters under the headings, "Application of the Exponential Formula in Anthropometry" and "The Exponential Formula and the Manifestations of Life in Human Society." In these chapters Westergaard points out the necessity of testing whether the formulae from the calculus of probability can be applied directly to the statistical series. In other words, the question is of the stability of the statistical series tested by means of the mathematical theory of probability.

To the present reviewer it seems, however, that Professor Westergaard instead of using the somewhat lengthy tests by means of the normal error curve would have reached his goal quicker by aid of the so-called Lexian-Charlier dispersion theory. When one compares the striking illustrations of this theory in the recent work, "The Mathematical Theory of Probability and Its Application to Frequency Curves and Statistical Methods" (Vol. I, New York, 1916), by Professor Westergaard's colleague and compatriot, Mr. Arne Fisher, the superiority in some respects of the treatment of Mr. Fisher over that of his older and renowned countryman becomes evident. The Charlier coefficient of disturbancy, which is computed without much trouble, affords a very sensitive and powerful criterion for determining the possible presence of disturbing influences in the collected data. Charlier and Fisher have also given a simple mathematical method for eliminating secular perturbations in the collected data. It is to be regretted that these methods are not mentioned in Westergaard's book.

The eleventh chapter contains an excellent representation of interpolation and graduation methods. Those who have read the treatment of the same subject by Bowley will welcome the lucid and striking mathematical demonstration of the various formulae derived from the very general formula of Newton, at the hands of Westergaard.

The chapter on frequency curves shows that the Danish statistician keeps abreast of the modern mathematical development. Here he deals with Pareto's Law, the Curve of Utility, the Makeham Mortality Curves, and the frequency curves in their narrower sense. His treatment is too brief, however, to be of much practical value in actual calculations. Moreover, an error has crept into his demonstration of the computation of the parameters by means of Thiele's half invariants.

Finally, Westergaard discusses the theory of correlation based upon the method of moments and least squares in a most acceptable manner. This part fully exposes the error made by Professor West in the September number of this QUARTERLY, 1916, when he stated that Professor Westergaard apparently was not familiar with the properties of the correlation ratio. The whole trouble with the method of correlation lies at present in the fact that its mathematical theory is as yet unfinished. In this field the modern Scandinavian school of mathematical statisticians, such as C. V. L. Char-

lier, Sven Wicksell, N. R. Jörgensen and Arne Fisher is at present doing a veritable yeoman's service, and there is no doubt that before long we shall have a sound theory to build upon. The reviewer fully agrees with Westergaard that before this theory is finished much energy will be wasted through the efforts of some American economists in the application of the incomplete theory to economic problems. The mathematicians, however, are not to blame for blunders committed by economists who insist upon using the tools of an unfinished and incomplete mathematical theory to various complicated economic problems. A dull saw does not work very well, especially in knotty pieces of wood.

In others chapters Westergaard treats numerous practical problems from the fields of economics and insurance, such as the theory and use of index numbers, laws of wages, price theories and the theory of risk. Many of these chapters have become small gems of concentration and clear exposition of thought. The Danish statistician has here, on 6 to 7 pages, imparted more real knowledge than some of his American colleagues have spread over more than 80 pages of mere verbalisms.

The reviewer warmly recommends Professor Westergaard's splendid book on mathematical statistics. He is fully convinced, moreover, that the apparent criticisms by Westergaard of the advocates of ultramatematical methods in statistics has reference only to those who—to borrow a phrase from another eminent Danish scholar and statistician, the biologist Johannsen—habitually "treat statistics as mathematics and not *with* mathematics." The erroneous view which Westergaard's recent articles may have created in certain American circles arises solely from the fact that what he is apt to regard as elementary statistics are considered as higher mathematics by the majority of his American colleagues, and what he conceives of as higher mathematics is quite beyond the comprehension of most of our present day statisticians.

T. W.

COMMITTEE WORK IN FEDERAL STATISTICS AND LEGISLATION FOR THE FOURTEENTH AND SUBSEQUENT DECENTNIAL CENSUSES.

In a paper read at the meeting of this Association at Princeton, N. J., December 29, 1914, Dr. S. N. D. North, Director of the Census from 1903 to 1909, suggested* that economists and statisticians take counsel of each other as to what course they could best pursue to promote the interests of governmental statistics, especially in view of the approaching Federal Decennial Census of 1920. Dr. North's paper was a continuation of part of the theme of Professor Willcox's article in the *Political Science Quarterly* for September, 1914. The Executive Board of our Association, acting upon this and other suggestions, appointed a Committee on Federal Statistics to coöperate with a similar committee of the American Economic As-

*"The Census Office in Commission." *QUARTERLY PUBLICATIONS* of the American Statistical Association, Vol. XIV, p. 467